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Nanoscale domain structures and local property characterization of multiferroic materials via Scanning Probe Microscopy

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In this work, high resolution, scanning thermal-piezoelectric microscopy (SThPM) was developed based on based on the previous piezoresponse force microscopy and 3ω-scanning thermal microscopy, and was applied to perform studies of nanoscale domains and their electrical, thermal behavior of multiferroic materials.

SThPM was used to investigate nanodomains and their electromechanical and thermal response of BFO thin films. The domain wall width was found to be 1.8nm in well consistent with that of first principle calculations. SThPM was also employed to explore the polarization dynamics and local I-V behavior of Mn-BiFeO3 thin films deposited at different oxygen pressure. Local thermal conductivities (λ) at domains and domain walls are closely related to the inhomogeneous stress distribution around them. The abnormal electromechanical responses, induced by the tip fields applied to the epitaxial BFO thin films, were firstly observed. The possible underlying mechanism for it was proposed. SThPM provides a powerful tool for in-situ characterizing local electromechanical and thermal properties of multiferroic materials and devices.